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L. O. HOWARD, Chief

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THE EGGPLANT TORTOISE BEETLE.

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INTRODUCTION.

During the spring of 1915 the larva of a tortoise beetle, *Cassida pallidula* Boh., was observed in injurious numbers on the foliage of young eggplant and on the leaves of Irish potato at Baton Rouge, La. While injury to eggplant by this species was mentioned by Riley, under the name of *Cassida texana* Cr., as early as 1882 (2),[1] and while other writers have referred to its presence on wild Solanums, no comprehensive article regarding it has been published. During 1915 the writer, assisted by Mr. C. E. Smith, of the Bureau of Entomology, kept the insect under observation at Baton Rouge, La., studying its life history and habits and conducting control experiments with insecticides. Although the species has not been found to be a pest of first-class importance to the plants which it attacks, it is apparent that it is, at times at least, destructive enough to its cultivated hosts to warrant the use of insecticides for its control.

DISTRIBUTION.

The species is somewhat widely distributed over the more southern portions of the United States. Riley (2) has recorded it from southern Texas and Washington, D. C., Coquillett (4) reported its presence in California, and Blatchley (6) lists it in his "Coleoptera of Indiana." It also occurs in Missouri, Kansas, Oklahoma, New Mexico, and Arizona (7, 8).

HOST PLANTS.

Riley (2, 3) has recorded it as feeding on *Solanum elaeagnifolium*, *S. carolinense*, and eggplant, and Coquillett (4) found it on *Solanum xanti* in California. Wickham (5) has stated that he saw it feeding on Solanum in the lower Rio Grande Valley. At Baton Rouge, La., it has been found on *Solanum carolinense*, eggplant, and Irish potato.

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[1] Figures in parenthesis refer to "Bibliography," p. 8.

DESCRIPTION.

THE EGG.

The egg (fig. 1) is ellipsoidal in shape and creamy white when first deposited, later becoming brownish. Ten eggs gave an average length of 1.24 mm., ranging from 1.16 to 1.30 mm., and an average width of 0.67 mm., ranging from 0.62 to 0.76 mm.

THE FIRST-STAGE LARVA.

The general color is greenish white, with light, dirty brown head, and with the tips of the mandibles and the claws dark brown. The head and legs are large and out of proportion to the rest of the insect. The surface of the body is sparingly covered with short spines. Sixteen pairs of branched appendages extend from the sides of the body, the branches being larger on the anterior pair. Another pair of long appendages originates on the dorsal surface of the body, just anterior to the anus, and it is upon this pair that the excrement and cast skins, commonly known as the "pack," are carried, the pair of appendages sometimes being called the "fæcifork." The length of the first-stage larva, including the head, is about 1.5 mm. and the width of the head about 0.46 mm.

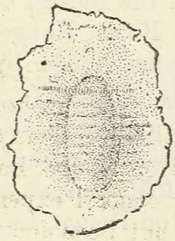

FIG. 1.—Eggplant tortoise beetle (*Cassida pallidula*): Egg. Greatly enlarged. (Original.)

THE SUCCEEDING LARVAL STAGES.

There are in all five larval stages. The principal difference between them is the increase in size after each molt, the full-grown larva measuring from 5 to 5.5 mm. in length.

There is some variation in the position of the appendages along the sides of the body in the various stages. After the first molt the head and legs are smaller in comparison with the growth of the body and are not so conspicuously out of proportion as in the first instar. The color of the body in the second and in the succeeding stages is light green, sometimes tinged with yellow. The cast larval skins of the various stages are often retained on the fæcifork up to the time the larva is ready to transform to the pupa. They are arranged consecutively, that of the first nymphal stage nearest the tip of the fork and with the head molts on the upper surface of the pack as it is held over the dorsal surface of the body.

The width of the heads of individuals in any one stage is quite constant, that of the second instar being about 0.55 mm., that of the third about 0.67 mm., that of the fourth about 0.82 mm., and that of the fifth about 0.97 mm.

THE PUPA.

The fringe of appendages persists in the pupa, there being five branched pairs on the sides of the abdomen and about 45 smaller appendages around the edge of the prominent thoracic shield. The antennæ, legs, and wings of the adult are evident on the ventral surface, held against the body. Portions of the larval molts adhere to the blunt tip of the abdomen, by which the pupa is attached to the surface upon which it rests.

Measurements of five individuals gave an average length of 5.4 mm., the length varying from 5 to 5.5 mm. The average width of the thoracic shield was 2.9 mm.

THE ADULT.

The following description of the adult (fig. 2.) is taken from Blatchley (6):

> Oblong-ovate, sides nearly parallel. Uniform dull green or greenish-yellow; antennæ with last three joints piceous. Thorax twice as wide as long, the angles all broadly rounded; margin very broad, flat and translucent. Elytra with humeral angles prominent, margins broadly flattened, punctures very coarse and close-set; intervals narrow. Length 5–5.5 mm.

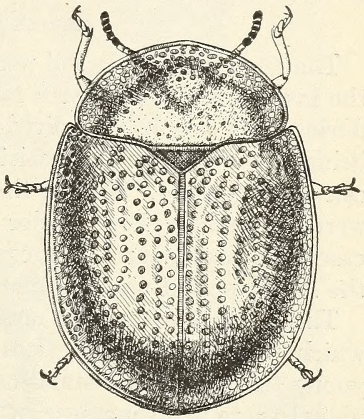

FIG. 2.—Eggplant tortoise beetle: Adult. Enlarged. (Original.)

DEVELOPMENT.

OVIPOSITION.

On eggplant the greater number of the eggs have been found on the underside of the leaves, although they are also placed on the surface and sometimes on other portions of the plant. While as many as four eggs have been found together, they are usually placed singly or in groups of two or three eggs each. Where more than one egg occurs they are placed one above another. Surrounding the egg and extending from it in the plane of its greatest circumference, to form a more or less rectangular flake, is a thin, transparent layer of membranous substance having a brownish tinge. Covering this, almost without exception, is a second, larger flake of the same material. These are attached to each other at the end where the flake inclosing the egg is attached to the surface upon which it is placed.

Eggs were first noted in the field at Baton Rouge, La., on May 11 and were present as late as September.

PERIOD OF INCUBATION.

During June the period of incubation of eggs kept in the insectary was quite constant, the larvæ issuing in from four to five days after the eggs had been deposited.

The following table gives the mean maximum and minimum temperatures for the insectary where the life-history studies were conducted, and the corresponding figures given for Baton Rouge by the United States Weather Bureau. Readings were taken each morning from a maximum and minimum thermometer.

TABLE I.—*Mean maximum and minimum temperatures at Baton Rouge, La., during June, July, and August, 1915, when life-history studies on eggplant tortoise beetle were conducted.*

Period.	U. S. Weather Bureau, mean temperatures.[1]		Insectary, mean temperatures.		Excess of mean insectary temperatures over those of U. S. Weather Bureau.	
	Max.	Min.	Max.	Min.	Max.	Min.
	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*
June	91.5	72.3	94.9	73.9	3.4	1.6
July	92.5	71.9	95.4	74.8	2.9	2.9
August	91.3	70.0	92.1	74.0	.8	4.0

[1] Climatological data, Louisiana section, for months of June, July, and August, 1915, by Isaac M. Cline, pp. 46, 54, 62, New Orleans, La., 1915.

LENGTH OF LARVAL PERIOD.

The length of the larval period has been found to vary greatly in the insectary. Forty-three larvæ that were kept under observation during June and July required from 12 to 20 days to develop, 17 days being the average. No satisfactory reason for this wide difference can be suggested. Larvæ that issued on the same day and which were apparently kept under similar conditions pupated, in some cases, six days apart. On eggplant grown under cages out of doors the larval period was completed in 12 days during June.

The larvæ are sluggish and occur on both sides of the leaves, in which they eat more or less circular holes. When the larvæ are young these holes are small in size, but with the growth of the individual there is an increase in the quantity of tissue removed.

LENGTH OF PUPAL STAGE.

The pupal period occupied from two to seven days in the insectary during June and July, though most of the individuals remained in the pupal stage from four to five days.

LIFE AND HABITS OF ADULTS.

The adults, even during the summer, live for a period of several weeks. In the insectary one individual, a female, was kept alive from May 22 to October 9, two months after it had ceased to lay eggs, and others have lived for two or three months. The winter months are undoubtedly passed in the adult stage.

The injury done to the leaves of eggplant (fig. 3) by the adults is of the same character as that due to the larvæ, the feeding of the beetles producing holes which are somewhat circular in outline.

NUMBER OF EGGS DEPOSITED BY ONE FEMALE.

On July 4, beetles that had issued in rearing cages in the insectary, none of which had begun to oviposit, were placed together on eggplant leaves. The first eggs were noted on July 6, when the beetles were separated, except for a pair that was found copulating. The next day it was found that three females of this lot had deposited eggs, and these individuals were placed on eggplants growing in flowerpots. One of them was the female with which the male beetle had been placed and the male was kept with the female until the latter died. The eggs were removed each day and counted. The female which was paired with the male completed egg laying sooner than did the others, although it did not deposit as many eggs as did one of the isolated females. Toward the end of the period of oviposition a few objects, apparently eggs without the surrounding membrane, were noted on the leaves in the cages with the isolated female beetles. Larvæ failed to develop from these, however, and they were

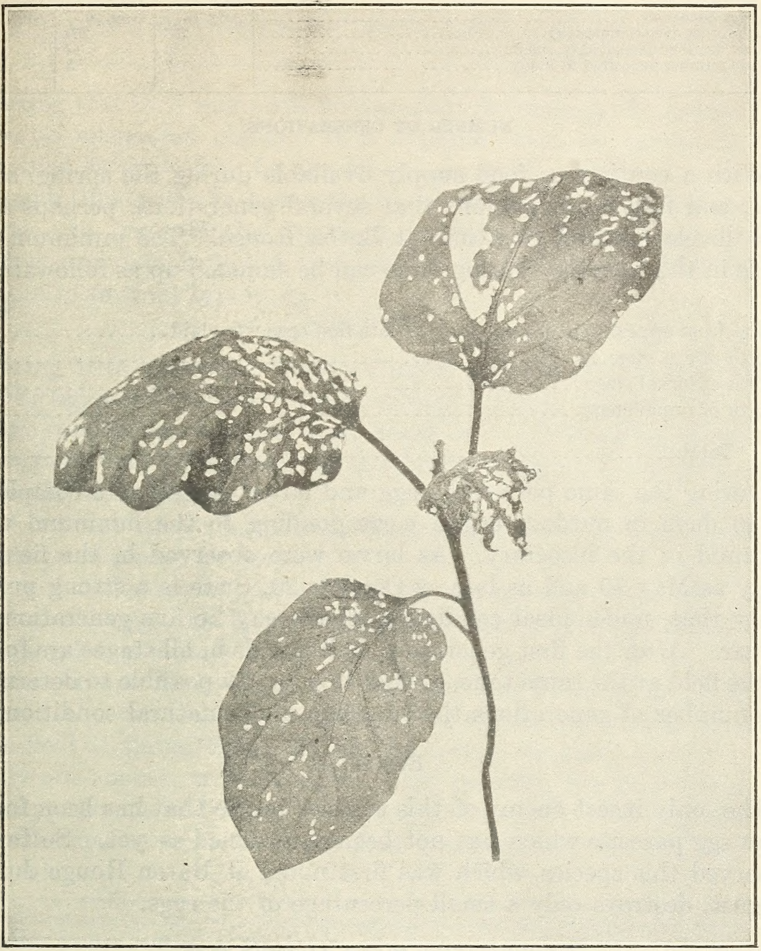

FIG. 3.—Young eggplant showing injury by the eggplant tortoise beetle. Reduced. (Original.)

not counted as eggs. The following data have been selected from the data concerning these three females:

TABLE II.—*Egg-laying records of three females of the eggplant tortoise beetle.*

	Female A.	Female B.	Female C.
Egg laying begun	July 7	July 7	July 7.
Last eggs deposited	Aug. 16	Aug. 26	Aug. 24.
Total number of eggs deposited	268	269	231
Greatest number deposited in one day	10	12	11
Average number deposited in a day	7	5	5

NUMBER OF GENERATIONS.

With a continuous food supply available during the spring, summer, and fall, it is apparent that several generations, perhaps five, will develop during this time at Baton Rouge. The minimum life cycle in the insectary during June can be summed up as follows:[1]

	Days.
Period from appearance of first adult to date first eggs were laid	9
Length of egg stage	4
Length of larval stage	12
Length of pupal stage	2
Total	27

During the same period the egg and larval stages were completed in 16 days in outdoor cages, corresponding to the minimum time required in the insectary. As larvæ were observed in the field as early as May 10 and as late as October 20, there is a strong probability that, under ideal conditions, there may be five generations in a year. After the first generation, individuals in all stages are found in the field at the same time, so that it is hardly possible to determine the number of generations that develop under natural conditions.

ENEMY.

The only insect enemy of this tortoise beetle that has been found is an egg parasite which has not been determined as yet. So far as observed this species, which was first noted at Baton Rouge during August, destroys only a small percentage of the eggs.

EXPERIMENT WITH ARSENICALS.

During May larvæ were causing sufficient injury to small eggplant at Baton Rouge to warrant the application of poison to the plants, and an experiment with arsenate of lead and arsenite of zinc was conducted, the application being made with a compressed-air sprayer. From this experiment the following summary has been made:

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[1] Somes (7) found in Missouri that from eggs laid in July a longer period was required for the development of a generation.

TABLE III.—*Results of arsenical sprays against the eggplant tortoise beetle.*

Treatment.	Number of larvæ on 25 plants before spraying.	Number of larvæ on same plants 2 days after spraying.	Number of larvæ on same plants 4 days after spraying.
Sprayed with arsenate of lead, powdered, at rate of 1 pound to 50 gallons of water	85	14	2
Sprayed with arsenite of zinc, powdered, at rate of 1 pound to 50 gallons of water	93	12	2

During this time there was no apparent decrease in the number of larvæ on unsprayed plants. It is apparent that the larvæ can be controlled satisfactorily by the use of an arsenical which might, at the same time, serve to lessen the injury caused by other leaf-eating insects. In transplanting eggplant in sections where this tortoise beetle is abundant it would be advisable to dip them in some spray mixture to prevent injury.

SUMMARY.

During 1915 a tortoise beetle (*Cassida pallidula* Boh.) was found injuring eggplant and Irish potato at Baton Rouge, La.

This species has hitherto been recorded as feeding on eggplant and various wild Solanums.[1] It is somewhat widely distributed over the southern United States.

The various stages have been described from life-history studies carried on at Baton Rouge.

Three females reared in the insectary deposited, respectively, 268, 269, and 231 eggs, one laying as many as 12 in one day, and another averaging 7 eggs a day.

The minimum life cycle in the insectary was found to be 27 days. Under ideal conditions it is possible that five generations may develop in the field at Baton Rouge during the spring, summer, and fall.

Only one enemy, an undetermined egg parasite, has been noted.

An experiment with arsenate of lead and arsenite of zinc indicates that the species can be controlled satisfactorily by the use of arsenicals.

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[1] Numerous observations have been made of this species and its occurrence on solanaceous plants, many of which have not been recorded. In 1903, June 12, it was observed at Riverview, Md., on wild Solanum. May 4, 1903, it was observed by Mr. J. C. Bridwell at Willis, Tex., on *Solanum carolinense*. He also observed this species on the same plant in Kansas in earlier years. May 8, 1908, and March 31, 1909, Messrs. McMillan and Marsh observed this species on *Solanum elaeagnifolium*. February 6, 1912, Mr. M. Beatty observed this species on potato and eggplant at New Orleans, La. During June, 1915, the species was observed on eggplant by Mr. F. B. Milliken, at Wichita, Kans. We have received specimens from Kansas City, Mo., and from Agricultural College, Miss., the latter collected by Mr. J. W. Bailey, on eggplant.—F. H. CHITTENDEN.

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